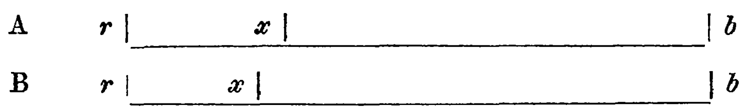
Improved Form of Object-Glass, deduced from a Critical Analysis of the Secondary Spectrum. By A. Dawson, Esq.

It has ever since the first discovery of the secondary spectrum been supposed that by using flint and crown glass alone it could never be corrected or avoided. This I have lately found both by theory and experiment to be a mistake; and although at first sight it may appear impossible to alter the proportion of the coloured spaces in the spectrum of the flint glass, yet there is a way of producing this result without in any way interfering either with the constituents of the glass, or with the optical arrangement by the interposition of any extraneous substance whatever.

To make this easily understood it will be needful to present an exact analysis of the secondary spectrum, and this we will now see to.

The constitution of the primary spectra then is such



that if A be the spectrum of the crown glass, while B is that of the flint glass, then as they are both coincident at the extremities, the brightest parts x do not coincide.

Now, if an object-glass be made in which the spectra coincide in the above manner, it is clear that although there may be no stray light as arising from the overlapping of the extremities, yet what will be worse will take place, the non-coincidence of the brightest parts of the spectra; thus there will be a secondary spectrum of whitish light and considerable brightness.

But supposing that the flint glass is made a little deeper in its curves, then its spectrum will be placed further out from the axis like this,

and then the brightest x coincides while the extremities overlap, so that the flint glass brings the blue outwards, while the crown glass brings the red inwards, and as these are the dullest parts of the spectra it is much better than when the extremities coincide at the expense of the central parts. This then is the correction always aimed at as producing the greatest clearness in the image, and from the fact that the overlapping red rays have the shortest focus while the blue rays have a long focus, it is said to be "over corrected," though in real fact it is a truer correction than the first case.

It will be needless to refer to the various methods whereby this has been at different times removed, though never yet with permanence; suffice it to say, that until now it has never been accomplished with the ordinary flint and crown glass.

It will appear at once on inspection of the diagrams, that the desired end will be attained if we can by any means cause the blue half of the flint glass spectrum to contract, while the red half is expanded.

This I may as well state at once may be done by refraction.

Suppose, for instance, that the blue rays from the crown glass are made to fall more perpendicularly on the flint glass than the mean, while the red rays are made to fall on it at a lower angle than the mean; it will be clear then that the blue rays will be less refracted, while the red rays will be more refracted, than they otherwise would be.

Now although this seems a difficult condition to fulfil, yet it may be done by *drawing the flint glass to a proper distance behind the crown glass*, when the mean rays will fall on it at a mean angle; but the red rays falling on a part nearer the edge of the flint glass, the refracting surface of that glass will have moved through such a curve as to cause them to fall on it at a lower angle of incidence and so to suffer more refraction; on the other hand, the blue rays being situated nearer the axis they will fall upon the refracting surface of the flint glass with a higher angle of incidence, and so suffer less refraction, the two together conspiring to make the spectrum of the flint glass like that of the crown glass.

Having thus satisfied myself of the principle, it became needful to ascertain how far it could be worked out in practice.

This I tried on a glass of $3\frac{1}{2}$ inches aperture and 5 feet focus, but soon found that the drawing back of the flint glass threw out the focus prodigiously, to avoid which I coupled it with a crown lens which negatived all the refraction of the flint glass, but left a great part of its dispersion. Then after 3 or 4 more alterations I got it so that the secondary spectrum, if not completely corrected, could certainly not be found under any common test.

But that which gave the most conclusive proof of its success must now be detailed.

I had previously bestowed nearly all my study on the figuring of the surfaces of lenses, so that if I wished I could work a surface to such a form, that on the one hand the spherical aberration might be *positive;* and on the other hand the figure might be hyperbolic, making the spherical aberration *negative.*

This then offered a simple and conclusive mode of testing the success of the experiment, for by forming it with the middle and edges polished away so that the spherical aberra-

tion was positive, the expanded disk of a star as seen at the short focus ought to show a bright margin, without any stray light outside this; but if it was made hyperbolic, the same effect ought to take place at the long focus, and still with no stray light outside the expanded disk.

But if there remained any residual secondary spectrum of that kind which obtains in an apparently exactly corrected ordinary achromatic, the expanded disk would at the short focus have appeared as it ought, while that produced by the hyperbolic form at the long focus would have stray light round it; thus by figuring it became easy to distinguish the error produced by the secondary spectrum from that produced by any accidental error in the figure of the lenses.

During the working up then I brought it to these curves successively, and was gratified to find that under each condition it answered exactly as it ought, the question being thereby demonstrated much more satisfactorily and conclusively than any direct observation could do it.

Solar Eclipse of March 6, 1867. By C. L. Prince, Esq.

The weather this morning was very unfavourable for observing this eclipse. At 19^h L.S.T. the sky was obscured by large masses of flocculent cumuli and small masses of cumulo strata, the latter at a high elevation, presenting a very peculiar appearance not unlike distant snow-storms. It was not until $19^h\ 16^m$ that I first caught a glimpse of the Sun through my 12-feet Equatoreal of 7 inches aperture. The Moon had by that time considerably advanced upon the solar disk. I had decided upon using the lowest power (120) of my Dawes' solar eye-piece, but I found the atmosphere in such a disturbed, tremulous state that I could not satisfactorily use it. I therefore contracted the aperture to 4 inches and made use of a very low power (30), shaded by a neutral tinted glass, which gives a large field of rather more than one degree, and beautiful definition. From $19^h\ 20^m$ to $19^h\ 39^m$ the clouds were so dense that I could discern the Sun, at intervals only, through them. After this time the Sun shone almost brightly for the space of half an hour. At $19^h\ 42^m\ 47^s$ I observed a remarkable stream of magenta-coloured light pass suddenly along the whole of the preceding edge of the Moon's disk *from* south *to* north. This appearance was as though a large brush of paint had been quickly dashed upon it. The same tint appeared again slightly (but along the whole preceding limb of the Moon simultaneously) at $1^h 9\ 14^m$ for 10 seconds, slightly again at $19^h\ 54^m\ 13^s$, and at